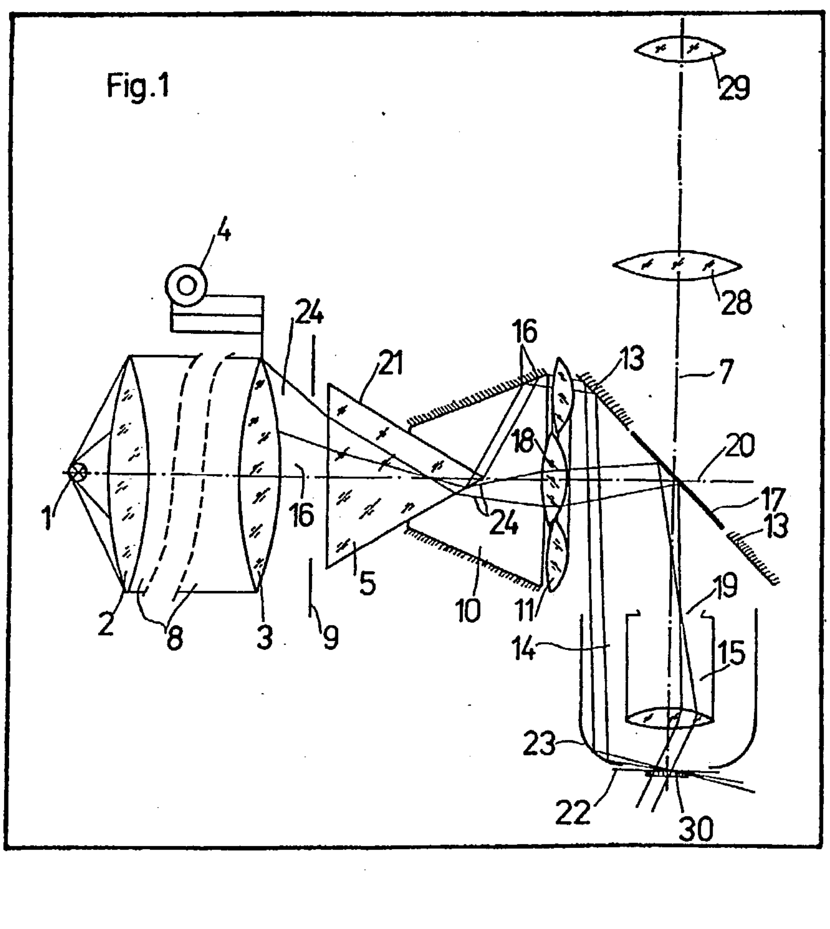
(12) UK Patent Application (19) GB (11) 2 058 393 A

(21) Application No 8027178
(22) Date of filing 21 Aug 1980
(30) Priority data
(31) 215184
(32) 27 Aug 1979
(33) Dem. Rep. of Germany (DD)
(43) Application published 8 Apr 1981
(51) INT CL^3 G02B 21/08
(52) Domestic classification G2J 8B
(56) Documents cited
GB 2034071A
GB 1546513
GB 1493099
GB 1320671
GB 389414
GB 386281
GB 385907
GB 379228
GB 348202
(58) Field of search G2J
(71) Applicant
VeB Carl Zeiss Jena, 69 Jena, 1, Carl-Zeiss-Strasse, German Democratic Republic
(72) Inventor
Johannes Grosser
(74) Agent
W. P. Thompson & Co., Coopers Building, Church Street, Liverpool L1 3AB

(54) Illumination Arrangement for Microscopes

(57) The arrangement which can be used to perform dark field and/or annular illumination of microscopic samples by incident (shown) or transmitted light, includes a system (3) for aperture increase, an iris diaphragm (9), an optical cone (5), a toroidal reflecting face (10) and an imaging system (11, 13, 17) or an objective are arranged between a collimating lens of the microscope and a phase ring plane (19). Dark field illumination is obtained by the annular beam emitted from annular lens 11 and direct illumination from the central beam emitted from lens 18.



GB 2 058 393 A

2058393

1/24

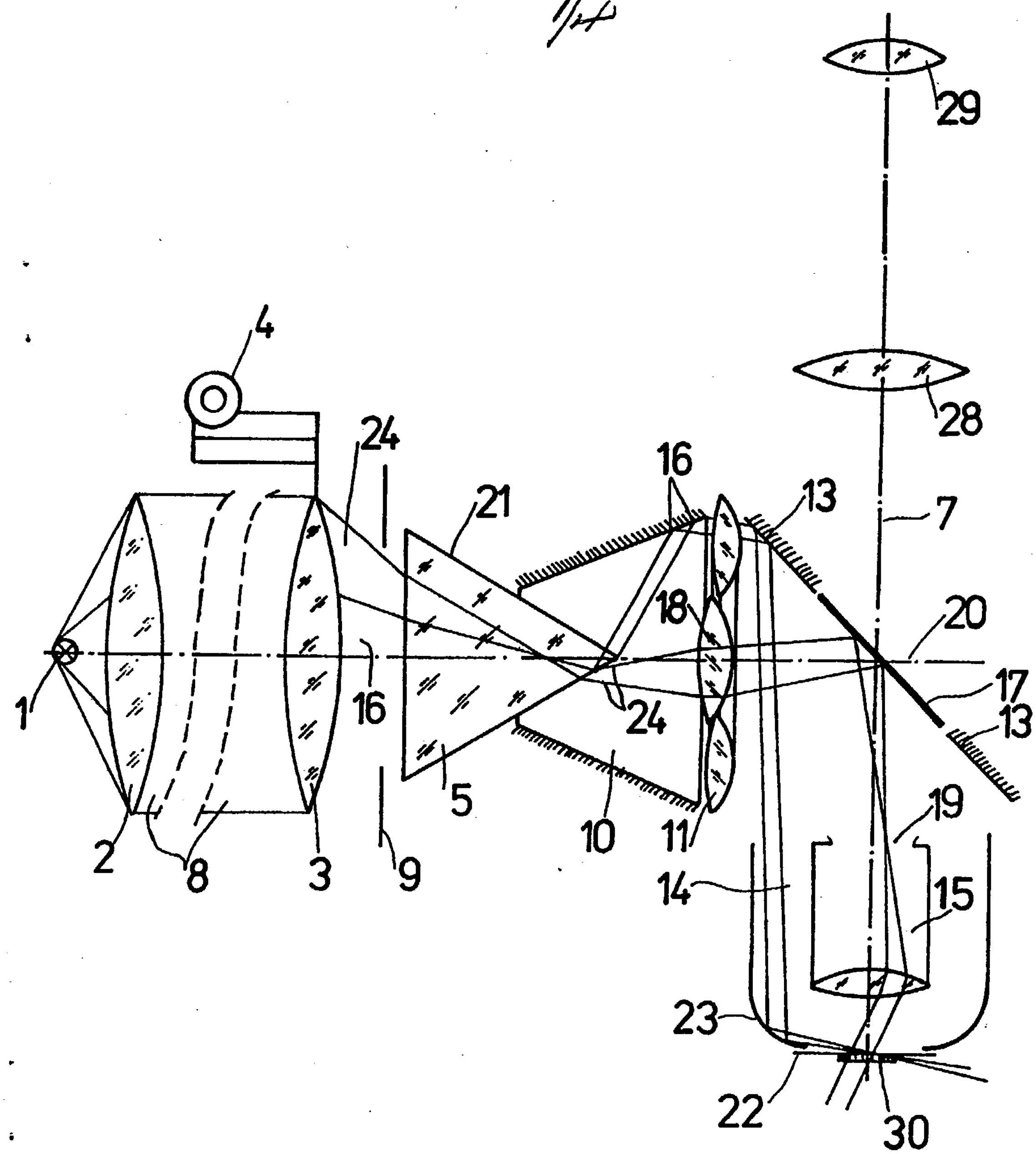


Fig.1

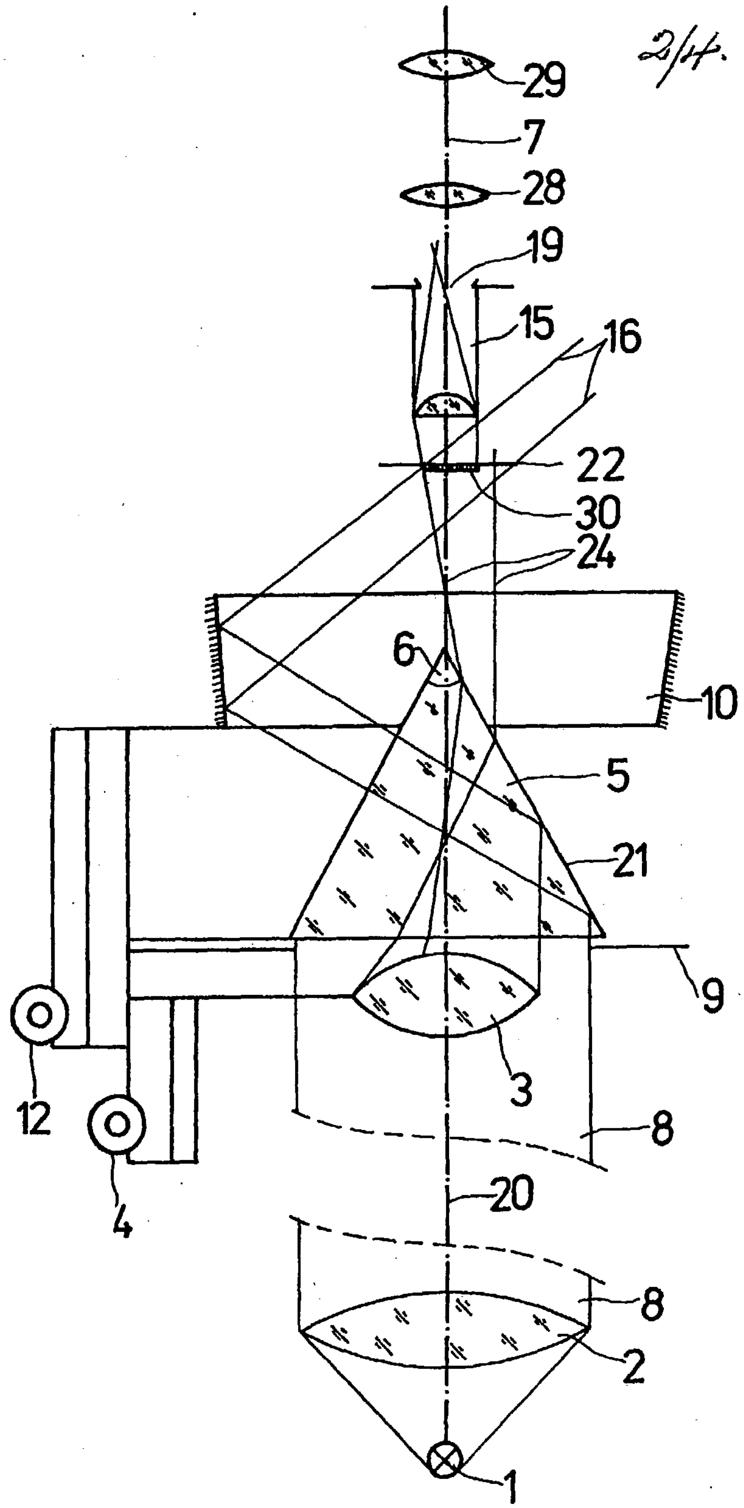


Fig. 2

2058393

3/4

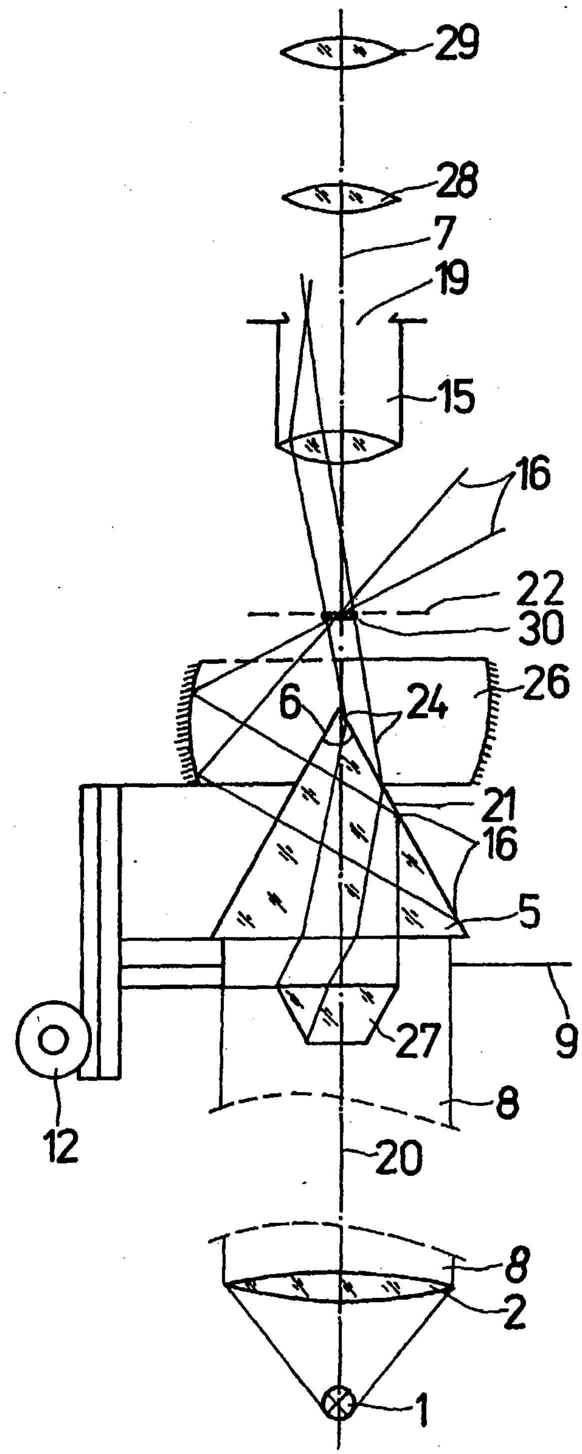


Fig. 3

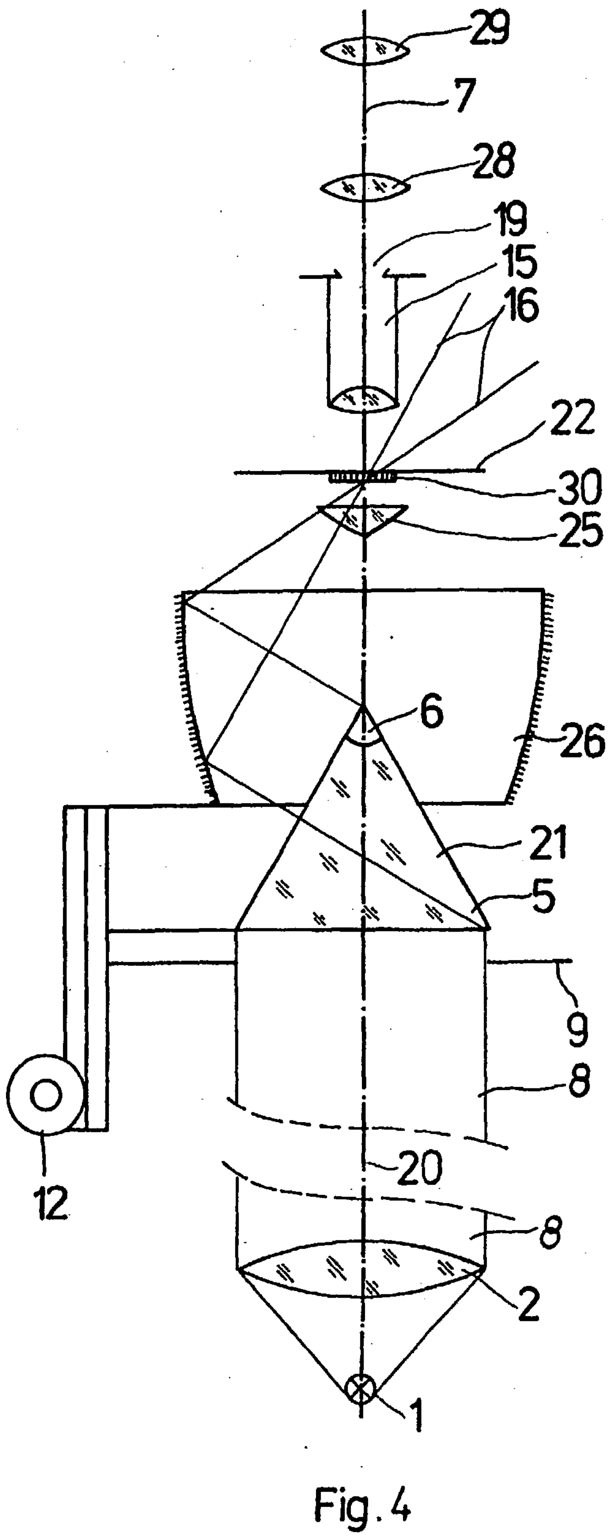


Fig. 4

SPECIFICATION

Illumination Arrangement for Microscopes

The invention relates to an arrangement for illuminating samples being examined in a microscopic in reflected and incident light.

The illumination arrangement permits a simultaneous and alternating dark field and annular illumination for bright field and phase contrast observations, respectively. A known technical solution of a dark field condenser lens is a bi-reflecting condenser which consists of two differently curved spheric faces.

Said condenser lens is disadvantageous since the central range of the bundle of light originating from the collimating lens cannot be utilized.

Furthermore, only a dark field illumination of not too large object fields is feasible.

Another solution offers the Heine condenser lens, where the dark field illumination is also carried out by a bi-reflecting system. A further plane reflecting face serves to utilize partially the central range of a bundle of beams originating from the collimating lens for a central and peripheric, respectively, bright field and phase contrast illumination.

This condenser has the advantage that a fast change-over between central bright field, phase contrast and peripheric bright field or dark field illumination is feasible. The change is executed by displacing the entire reflecting members which involves the disadvantage that damage to the objective cannot be eliminated.

A simultaneous setting of dark field and phase contrast illumination is not feasible. Furthermore, only one phase ring can be illuminated.

The previous illumination arrangements for dark-field operation under reflected light do not permit to utilize the entire light from the collector lens, since no discontinuity reflection faces are used. This and the fact that no beam splitting by an aperture takes place are the reasons why the dark-field and the phase contrast are not feasible at the same time.

It is an object of the prevent invention to obviate the above disadvantages.

It is a further object of the invention to provide an illumination arrangement for reflected light and incident light operation of a microscope at a fast change-over between the illumination kinds of central bright-field, central phase-contrast, peripheric bright-field and peripheric dark-field.

It is still a further object of the invention to provide an illumination arrangement which permits a simultaneous setting of dark-field illumination and phase-contrast illumination and to render adjustable the brightness of the superimposed images.

It is still a further object of the invention to obtain the illumination of considerably large object fields at dark-field, and to entirely exploit the light bundle originating from the collector lens.

The invention relates to an illumination arrangement for microscopes to perform dark field and/or annular illumination of microscopic samples, wherein a system for aperture increase, an iris diaphragm, an optical cone, a toroidal reflecting face and an imaging system or an objective are arranged between a collimating lens of the microscope and a phase ring plane. The entire bundle of beams originating from the collimating lens is rotation symmetrically deviated at the cone shell where it is subject to total reflection and is subsequently reflected via the toroidal reflecting face to the object in the event of reflected light operation, or in the event of incident light operation to the annular reflector for dark field illumination.

The toroidal reflecting face can have a radious of curvature at infinity, that is, it is a conic reflecting face. By insertion of a system to increase the aperture, such as a positive lens or a truncated cone the total reflection at the cone shell is partially eliminated. These beams pass the cone as refracted ones and are subsequently focused by a collimating system into the phase ring plane of the objective.

Thus the path of beams for phase contrast illumination is directed by a system for increasing the aperture, a rotation symmetrically deflecting system and a collimating system.

In the reflected light operation the collecting function is substantially performed by the objective, whereas under incident light an additional system is used. The aperture variation for the bundle of beams originating from the collimating lens opens a second illumination channel for lower illumination apertures with respect to severely inclined beams.

Thus two different channels for illuminating the object can become effective simultaneously in addition to the one-channel system which rotation symmetrically directs the beams.

In order that the invention may be more readily understood reference is made to the accompanying drawings which illustrate diagrammatically and by way of example four embodiments of the invention and in which:—

Fig. 1 shows an illumination arrangement for incident light,

Fig. 2 is an illumination arrangement for reflected light,

Fig. 3 is an illumination arrangement for reflected light employing a truncated cone,

Fig. 4 is an illumination arrangement for reflected light employing a final glass member.

According to Fig. 1, a light source 1 emitting a bundle of beams 8 is followed by a collimating lens 2 and a short focal positive lens 3 which serves to increase the aperture and can be switch out of or into the bundle of beams 8 by a conventional means (not shown).

The positive lens 3 is displaceable along an optical axis 20 by a drive mechanism 4; th diameter of the positive lens 3 corresponding to that of the bundle of beams 8 as transmitted by the collimating lens 2. Adjacent the positive lens 3, an iris diaphragm 9 is arranged followed by an optical cone 5 which is partially enveloped by a

toroidal reflecting face of a truncated refl cting cone 10. The toroidal face deviates an illumination beam 16 which is that portion of the bundle of beams 8 which runs near to an optical axis 20, that is, only slightly inclined relative to said axis 20.

Furthermore, an annular lens 11, an annular reflector 13 and an annular condenser lens 23 completing a dark-field channel 14 of an incident light objective 15 bring about the dark-field illumination.

Following the optical cone 5, a collimating lens 18 which serves as a light centering system is arranged about the optical axis 20 for focussing a light bundle 24 into a phase ring plane 19 of the incident-light objective 15 via a beam splitting reflector 17.

The light bundle 24 is the continuation of the near-axial portion of the bundle of beam 8, which after passing the lens 3 is the more severely inclined relative to the optical axis 20.

Furthermore, a tube lens 28 and an eyepiece 29 are arranged about an optical axis 7 which is also indicative of an imaging path of beams, the optical axis 7 and the optical axis 20 intercept in the plane of the beam splitter 17.

In operation, the bundle of beams 8 originating from the light source 1 and spread by the collimating lens 2 has a lower aperture and with the positive lens 3 switched out of the beams 8 is totally reflected at one face of side 21 of the cone 5 towards the opposing cone face.

The bundle of beams 16 leaving the cone 5 is subsequently deviated at the truncated cone reflector 10 to impinge upon the annular reflector 13 from where the beams are directed to the dark field channel 14; the annular condenser lens 23 focusses the beams into a setting plane 22 of the imaging path of beams 7. The annular lens 11 serves to adapt the width of the annular ring to the annular reflector 13 and to the dark field channel 14.

When the positive lens 3 is inserted into the path of beams 8 those beams which are not too severely inclined remain unvaried.

The more strongly inclined beams are refracted at the cone 5 rather than totally reflected.

In this event the angle of aperture 6 of the cone 5 and the focal length of the lens 3 are mutually matched. The lens 18 focusses the bundle of beams 24 after having been deviated at the beam splitting reflector 17, into the phase ring plane 19.

The diameter of the illuminated ring in the phase ring plane 19 is varied by displacing the positive lens 3. In this manner it is feasible with the positive lens 3 inserted to realise at the same time phase contrast illumination and dark field illumination.

The brightness of the phase contrast and dark field image is varied and mutually matched by operating the iris diaphragm 9.

The reflected light arrangement of Fig. 2 corresponds to that of Fig. 1 from the light source 1 on to the cone 5 and the truncated cone refl ctor 10. The diameter of the l ns 3 has been selected smaller than that of the light bundle 8 originating from the light source 1 and the collimating lens 2. The condenser unit comprising the positive lens 3, the cone 5 and the truncated cone reflector 10 is displaceable along the optical axis by means of an additional drive mechanism 12 and serves to adjust the maximum light concentration of the dark field illumination in the setting plane 22.

The object 30 is arranged in the setting plane 22 followed by the imaging members, the objective 15, the tube lens 28 and the eyepiece 29.

Apart from its imaging function the objective 15 has the task to focus the bundle of beams 24 in the vicinity of the phase ring plane 19.

This arrangement can be supplemented by an annular lens provided between the toroidal reflecting face 10 and the setting plane 22 and by an additional rotation symmetrically deviating member effective upon the path of beams 24.

In Fig. 3 a truncated cone 27 serves to increase the aperture instead of the positive lens 3 in Figs. 1 and 2. The truncated cone 27 is matched to the objective 15, and both are commonly exchangeable.

When two phase rings have to be illuminated a truncated double cone and a bifocal Fresnel lens, respectively, or an annular lens in co-operation with a positive lens can be employed.

The truncated reflecting cone 10 of Fig. 2 is replaced in this embodiment by a toroidal reflecting face 26 having a finite radius of curvature.

In the arrangement of Fig. 4 which is intended for use in reflected light the aperture increasing system is switched off.

The entire condensor unit is supplemented by a plano-convex optical element 25 which serves as an additional deflecting and collecting system for the phase contrast illumination.

The cone 5 includes a beam splitting face 31 to render the object illumination homogeneous.

The axis of symmetry of the cone 5 entirely lies in the beam splitting face 31.

Claims

1. An illumination arrangement for microscopes to perform dark field and/or annular illumination of microscopic samples, wherein a system for aperture increase, an iris diaphragm, an optical cone, a toroidal reflecting face and an imaging system or an objective are arranged between a collimating lens of the microscope and a phase ring plane.

2. An illumination arrangement as claimed in claim 1, wherein the system for aperture increase is arranged to be movabl out of the beam path and is axially displaceable.

3. An illumination arrangement as claimed in claim 1 or 2, wherein the toroidal reflecting face is additionally provided with an annular lens.

4. An illumination arrangement as claimed in claim 1, wher in a plano-convex optical element is arranged between the toroidal r flecting face

and the objective for reflected light illuminati n.

5. An illumination arrangement as claimed in claim 1, wherein the optical cone is provided with a beam splitting face coincident with the axis of symmetry of said cone.

6. An illumination arrangement for microscopes, substantially as hereinbefore described with reference to Figure 1 or to Figure 2 or to Figure 3 or to Figure 4 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.